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THE CLASSIFICATION OF THE LEPIDOPTERA ON
LARVAL CHARACTERS.

BY HARRISON G. DYAR.

Several articles¹ have appeared in the *AMERICAN NATURALIST*, presenting different views of the classification of the Lepidoptera. Certain studies on the larvæ have tended to show that there are characters of classificatory importance in this immature stage, and it may be interesting to compare the evidence furnished by them with that deduced from the mature structures.

Prof. V. L. Kellogg, accepting the division of the Lepidoptera into the suborders Jugatæ and Frenatæ, finds in the families of the former certain generalized characters in the mouth parts; but the Hepialidæ exhibit an atrophied condition. In the larvæ these conditions are reversed. The Hepialid larvæ present distinctly the characters of classificatory importance, while the leaf-mining Micropterygidæ are considerably atrophied. In the view advocated by Dr. A. S. Packard, the Hepialidæ are placed, not in a separate suborder, but low in the scale, near the Tortricidæ. Therefore, these larvæ will serve as something of a test between the two views advanced. Dr. Packard has discussed the larvæ of the Hepialidæ and quotes their characters as supporting his views, saying that the hairs are arranged in the same way as in normal Tortricid and Tineid larvæ "the four dorsal hairs arising from minute warts arranged in a low or short trapezoid." He has also given figures of several species (*Journ. N. Y. Ent. Soc.*, iii, 70, pls. iii and iv). This article is, however, open to criticism in two essential points. In the first place, the differential characters of the families of Lepidopterous larvæ do not reside in the dorsal warts. By this argument, Hepialus could equally well be proved to be a Noctuid or a Butterfly. In the second place, the figures of Hepialus larvæ do not show all of the

¹ *Am. Nat.*, March, June and August, 1895.

setæ, often not half of them. Probably they had become lost by attrition in the specimens drawn or possibly they were overlooked; but it is evident that any conclusions founded on these figures will require revision. Dr. Packard's figure of the first stage of *Hepialus mustelinus* is drawn in such a position that the lateral setæ do not show. I have, however, received some of these larvæ from Dr. Packard (who has very kindly furnished me with valuable specimens of larvæ which I should not otherwise have seen); I am able, therefore to present a more detailed drawing. (Fig. 1.)

I have shown in other publications² the general arrangement of the setæ common to all Tineids, Tortricids and other Microlepidoptera, and that the higher families, including the Noctuidæ, Sphingidæ and Butterflies are founded on the same type. The arrangement on the two last thoracic segments and on the abdomen is shown in Figure 5. This type includes what I call the subprimary setæ, certain ones common to all the Microlepidoptera and the Noctuids and their allies, but absent in the newly hatched larva and also in the highest families. They are marked by an asterisk in the figure. Now, clearly, if *Hepialus* belongs where placed in the view advocated by Dr. Packard, that is to say among the lower "Neolepidoptera," it should possess the subprimary setæ in the normal position. If, however, it belongs to a separate suborder, as the Jugatæ in the view supported by Prof. Kellogg, it should not have them, and for this reason: the subprimary setæ are not universal in the Frenatæ, but exist in two of the superfamilies (of my arrangement), not in the three others. Now *Hepialus*, if of the rank of a suborder, should show the generalized characters of the other suborder without its special acquired characters which might appear in some of the superfamilies. Therefore, the subprimary setæ should be absent, though this argument does not preclude the presence of other different subprimary setæ, or of other primary ones, not present in the Frenatæ.

Figures 1 and 2 show *Hepialus* in Stage I and mature. The subprimary setæ are absent but on the thorax are a set of

² Ann. N. Y. Acad. Sci., viii, 198; Trans. of the Same, xiv, 50, 1894-5.

setæ quite different from those of the *Frenatæ* marked + in Fig. 2a (mesothoracic segment), and also the primary setæ, which correspond to those of all other Lepidoptera. Thus *Hepialus* larva is not only a generalized form, but has pursued a line of development different from all *Micros* and *Noctuids*, the only larvæ in any way comparable with it in simplicity. With the three higher groups no one has recently thought of allying it, though formerly it was included among the "Bombyces." This evidence seems to me to be best interpreted as supporting the view that *Hepialus* represents a group of Lepidoptera (*Jugatæ*) as generalized as the lowest *Micros* and of subordinal rank.

However, let us see how favorable an interpretation to the other view can be put on the structures of *Hepialus* larvæ. That is to say, can the setæ be homologized with the *Tineidæ*? We recognize at once that no *Tineid* or related family has such a structure. They are remarkably uniform, for, when not degenerate, the arrangement of Figure 5 obtains, gradually modified in the higher forms by the approximation of iv and v on abdomen, then of i and ii also; on thorax ia and ib, iia and iib, iv and v, respectively, approximate. Therefore, *Hepialus* is neither typical nor does it represent a high development in the normal line. Still, on the abdomen, the fourth primary seta above the spiracle may correspond to the seta in *Cossus* hereinafter mentioned, but we must suppose this seta in *Cossus* to be primary; iv is out of line with v, more as in the *Noctuina*. Of the secondary setæ, the lower may correspond to vi, the upper is unexplained. On the thorax the upper anterior primary seta is unexplained; the two subprimaries may correspond to iii and v but moved up out of all association with iv. Thus by some violent movements we have homologized a part of the subprimary setæ of *Hepialus* with those of the *Tineidæ*. It is true that considerable movements may occur; I was deceived by such in my first explanation of the *Psychidæ*. Granting the possibility then, it could be argued that *Hepialus* may really belong with the *Tineidæ*, were it not for the two unexplained setæ; but the whole explanation is too forced to pursue further.

To turn now to the Protolepidoptera (Packard's suborder I). Aside from the generalized condition of the mouth parts and the body as a whole, no characters appear to prove that *Eriocephala* is entitled to subordinal rank. The possession of generalized characters is also called for in placing this genus in the Jugatæ. It is true that if the external lobe of the maxillæ corresponds to the tongue and not the inner (galea) in *Eriocephala* as Dr. Packard implies in his article, quoting Dr. Walter, we would have a real difference, indicating a dichotomous division. But Dr. Walter homologizes the true tongue of his "höheren Micropteryginen" (the Paleolepidoptera of Packard), also with the outer lobe, stating "Die Innenlade der Maxille ist indes völlig geschwunden. Als einzige Maxillarlade zieht sich hier ein zwar noch kurzes, aber typisch entwickeltes und leicht rollbares Rüsselchen" (Jena. zeit. für Naturwissenschaft, xviii, 761) and Prof. Kellogg thinks that it is the inner lobe in all cases that corresponds to the tongue (Am. Nat., June, 1895, p. 547), finding a rudiment of the outer lobe in the true Micropterygidæ.

The larva of *Eriocephala* is admittedly a specialized one. Not much is to be gained in discussing it, as it is in the interest of both views to show it different from most larvæ. Still I will show that the arrangement of the setæ may be derived from the Micropteryx type. Their form is unique and most interesting, but not valuable in classification.

I will briefly discuss, but in more detail, the characters of the larvæ of the several families of the Jugatæ, as far as they are known to me.

Suborder JUGATÆ.

Superfamily HEPIALIDES.³

Family *Hepialidæ*.

Hepiabus mustelinus. Stage I (Fig. 1). The prothoracic segment is normal for all generalized Lepidoptera. On the two posterior thoracic segments the primary setæ are present with

³ Grote, Syst. Lep. Hildeslæ, 1895.

an additional primary seta (marked + in the diagram Fig. 1c). On the abdomen, the primary setæ are present with a small additional one behind tubercle iii (+ in Fig. 1d). I am indebted to Dr. Packard for the specimen.

Hepialus humuli. Mature larva (Fig. 2). On the prothorax the cervical shield extends down to include the setæ before the spiracle. No setæ added to those in the first stage. On the last two segments the setæ are as in Stage I, without any of the true subprimary setæ (associated with iv and marked * in Fig. 5), but two different ones are present (marked * in Fig. 2a), associated with iib. On the abdomen there are present, besides the primary setæ, two subprimary ones (marked * in Fig. 2b). There are four primary setæ above the spiracle, which is unknown in any other Lepidoptera except in the Microlepidopterous genus *Cossus*, where the fourth seta is probably secondary (I have not seen Stage I of *Cossus*) and in the butterfly *Danaï*s, where it occupies a different position. The upper subprimary seta is without an analogue so far as I know. The lower one I have formerly interpreted as being the subprimary tubercle vi of the *Micros* (Ann. N. Y. Acad. Sci., viii, 198), but this was before I had examined considerable material. This interpretation is still possible, but in view of the fact that the tubercle is associated with vii as vi never is, and in view of the condition on the thorax, we cannot regard it as the homologue of vi.

Hepialus lupinulus. Mature larva. The structure is the same. I cite the species to show that the characters described above are generic and not individual. In my example (a blown specimen) a number of the setæ have been lost during the journey from Europe but the tubercles from which they arose can be distinguished plainly under a half inch objective in the proper positions.

Superfamily MICROPTERYGIDES.

Family *Micropterygidæ*.

Micropteryx purpurella. Mature larva (Fig. 3). The rudimentary setæ are difficult to distinguish. On the thorax I

discover but one seta to represent ia and ib ; the rest are present, but without any subprimary ones. On the abdomen the primitive arrangement prevails. I take the two lower setæ to represent vii and viii (the latter corresponding to one on the inside of the leg in *Hepialus*, which could not be shown in the figure) and consequently subprimary vi is absent. There is nothing here to contradict placing this genus with *Hepialus* in the suborder *Jugatæ*, but I do not emphasize the point, on account of the extreme reduction of the setæ. Larvæ kindly sent me by Dr. T. A. Chapman.

Family *Eriocephalidæ*.

Eriocephala calthella. Stage I (Fig. 4). Dr. Packard has kindly loaned me a slide of these larvæ prepared and given him by Dr. Chapman. Dr. Chapman has recorded many interesting observations on these larvæ (Trans. Ent. Soc. Lond., 1894, 337-344), but only the arrangement of the setæ concerns us here. Dr. Chapman's dorsal view (l. c. pl. vi, Fig. 1) corresponds with my own observations. His lateral views, however, are on a smaller scale and the lowest row of setæ has been omitted. It was apparently not seen, as it is stated in the text that there are "8 rows of globular appendages" or setæ, that is four on each side, whereas, in reality there are five rows. The two lower setæ on the prothorax also escaped observation. These corrections should be made to Dr. Chapman's account.

The setæ are highly modified and their arrangement has been much specialized as shown by the fact that the last two thoracic segments are like the abdomen. This is the case in no generalized type and has only been so perfectly attained in some of the highest lines of development in the *Frenatæ*. Nevertheless, by omitting seta iv on the thorax and iii on the abdomen, the arrangement could easily be derived from that of *Micropteryx*. I do not wish to suggest that this is the actual homology, for my material is too limited, but there seems nothing to preclude a derivation of *Eriocephala* from *Micropteryx*.

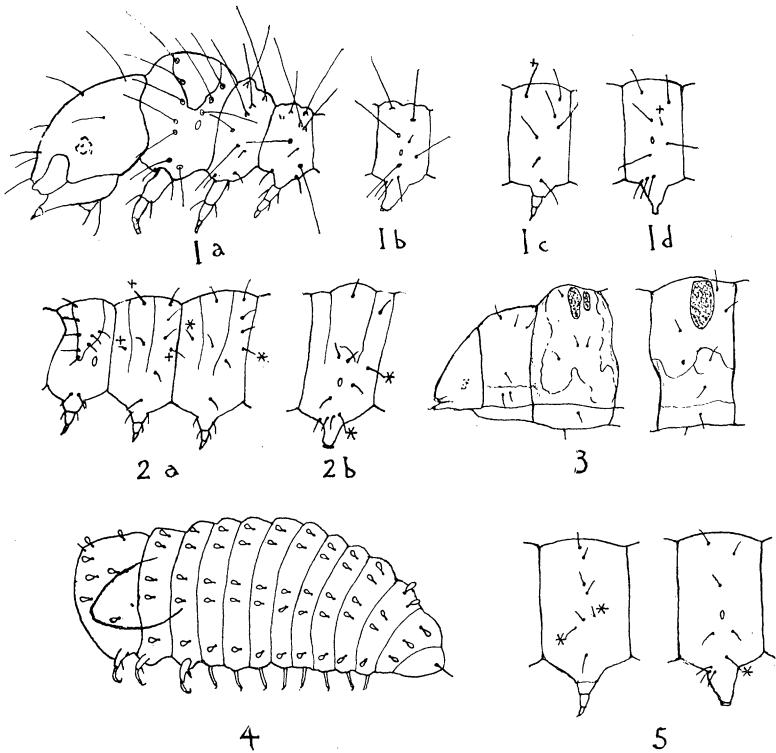
The curious abdominal legs are unique in the Lepidoptera. Probably they have been derived secondarily and have no homologues elsewhere. Dr. Chapman has endeavored to ally *Eriocephala* with the Limacodidæ (Eucleidæ). Certainly there are several curious and striking analogies,⁴ but I believe that these families really have no affinity. This is not the place for a discussion of the reasons for this view and I will only remark that the arrangement of the setæ is clearly not homologous.

EXPLANATION OF PLATE.

- Fig. 1. *Hepialus mustelinus*, Stage I, side view. *a*, head and thorax; *b*, one segment of abdomen; *c*, a thoracic segment made diagrammatic and the leg setæ omitted; *d*, an abdominal segment made diagrammatic.
- Fig. 2. *Hepialus humuli*, mature, a diagram of the setæ. *a*, thorax; *b*, an abdominal segment.
- Fig. 3. *Micropteryx purpurella*, mature, first two thoracic and an abdominal segment.
- Fig. 4. *Eriocephala calthella*, Stage I. The whole larva is represented, side view, but only the setæ are shown. The head is retracted and its outline appears by transparency.
- Fig. 5. A diagram of the metathoracic and abdominal setæ of the primitive Microlepidoptera (Tineides).

⁴ These are (1) the retractile head, (2) the angular outline of the body section, ridged subdorsally and laterally and bearing setæ on the ridges, (3) the presence of a series of dorsal and lateral intersegmental areas corresponding in position to the largest of the depressed spaces of the Eucleidæ, (4) the unusual number of abdominal legs, on the same segments as the suckers of the Eucleidæ, especially in the presence of a foot on joint 5 (first abdominal segment), which bears no appendage in any other Lepidopterous family than these two, and is also apodal in the phytophagic Hymenoptera, (5) the tendency to have the thoracic setæ arranged like the abdominal ones.

PLATE XXXVII.



Dyar on Lepidoptera.